Alameda County Santa Rita jail

1 MW fuel cell CHP system

Project Profile

combined heat & power in a jail

Quick Facts

Location: Dublin, Alameda County, CA

Capacity: 1 MW DFC1500 molten carbonate fuel cell (single module with four internal stacks)

Fuel: Natural gas

Noise Level: <70dB @ 10 feet

CHP system:

Waste heat for hot water and space heating

Construction Time: 7 months

System Online: May 2006

Total Project Cost:

$6,100,000 (without incentives or maintenance/stack replacement contract with Fuel Cell Energy)

Energy Cost Savings:

$264,000/year

Expected Payback Time:

14 years (with incentives)

Overall System Efficiency: 58%

Funding Sources:

Alameda County; CA PUC Self-Generation Incentive Program; U.S Department of Defense

Project Overview

In 1989, the Santa Rita jail was reopened at a 113-acre facility. Today, the jail holds about 4,000 inmates on 23 acres (9.3 hectares) and is considered the third largest county detention facility in California. Operating the facility is very resource and energy intensive. On food alone, they spend about $500,000 a month to produce 12,000 meals a day. The estimated electricity peak demand is 3.2 MW and therefore there is public pressure to make the operations more efficient. Alameda County has had a long history of using innovative approaches to increase energy efficiency and reduce public costs.

In May 2006 the County installed a 1 MW molten carbonate CHP fuel cell system in order to provide reliable onsite off-peak/base electricity and hot water pre-heating for domestic hot water needs. The system provides 8 million kWh/yr electricity (about 50% of demand) and 1.4 MMBtu/year of heat (410 kWh/yr = 18% of demand).

Prior to installing the fuel cell, in Spring 2002, the County put in a 3-acre (1.2 hectare) 1.2 MW solar system on the roof of the Santa Rita jail. In addition, the jail uses cool roof membranes and a "Demand Response Smart Control System" to manage the electricity demand of the facility.

Chevron Energy Solutions designed and managed the project and FuelCell Energy is responsible for ongoing maintenance. The single 1 MW DFC1500 480V AC system from FuelCell Energy was assembled on-site and is 26.5 feet (8m) high, 43 (13.1m) feet wide, and 40 feet (12.2m) long. The fuel cell power plant removes roughly 3000 tons of CO_2 emissions per year, which is equivalent to removing 520 cars from California roads or planting 830 acres (336 hectares) of forest.

Costs & Financial Incentives

The total project costs are estimated to be $6.1 million, including operating and maintenance costs. Alameda County signed a maintenance agreement with FuelCell Energy for 13 years. This agreement includes fuel cell stack replacements every 4-5 years and other periodic maintenance with average costs of about $200,000 to $300,000 per year. In the course of the fuel cell stack replacements, the rated capacity will increase to at least 1.2 MW because of

expected technical improvements in stack technology. The overall system lifetime is estimated to be 25 years, with total savings of $6.6 million over that time ($264,000 per year). To mitigate the $6.1 million in capital costs, Alameda County received $1.4 million from Pacific Gas and Electric through the California Self-Generation Incentive Program and $1.0 million from the U.S. Department of Defense's Climate Change Fuel Cell Program.

How does a molten carbonate fuel cell work?

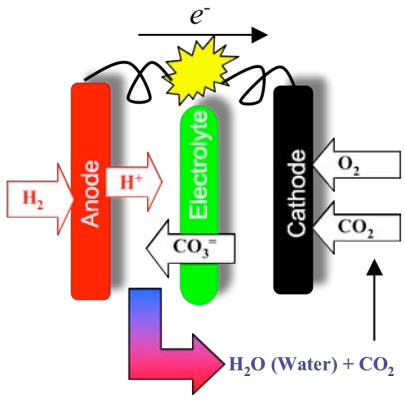
A fuel cell converts energy stored in a fuel and an oxidant into electricity through chemical reactions in the cell. In molten carbonate systems, these following reactions occur at the anode and cathode:

$$Anode: H_2 + CO_3^{=} \Rightarrow H_2O + CO_2 + 2e^-$$

$$Cathode: \tfrac{1}{2}O_2 + CO_2 + 2e^- \Rightarrow CO_3^{=}$$

This electrochemical conversion requires neither combustion nor any moving parts and unlike batteries, fuel cells do not store energy. Molten carbonate fuel cells have among the highest efficiencies of conversion (up to 60%); however, they require high temperatures, typically at 600 °C (1250 °F). At these high temperatures, non-precious metals can be used to catalyze the reaction, substantially bringing down the costs. On the anode, H_2 diffuses onto the anode catalyst (metal plate), which dissociates it into hydrogen (H^+) ions and electrons (e^-). At the cathode end, the electrons combine with oxygen (O_2) and carbon dioxide (CO_2) to form carbonate ions ($CO_3^{=}$) that diffuse through a molten carbonate electrolyte. When the $CO_3^{=}$ meets the H^+, water and CO_2 are formed, completing the flow of electrons.

Schematic of Molten Carbonate Fuel Cell



Above: 1 MW single direct fuel cell module at the Santa Rita jail

Below: Alameda County Transit operates three zero-emission fuel cell buses on a regular schedule

The fuel cell will provide about 50% of the jail's annual energy needs.

"A megawatt of power from the fuel cell covers base load electricity. And by pairing the plant with a solar array for peaking power, and utilizing waste heat for hot water, the entire system delivers the highest energy efficiency possible, while improving reliability"

R. Daniel Brdar, president and chief executive officer from FuelCell Energy.

Further information can be found at

Alameda County: www.acgov.org/gsa/energy.htm
Chevron Energy Solutions: www.chevronenergy.com
FuelCell Energy: *www.fuelcellenergy.com/*
Hydrogen, Fuel Cells and Infrastructure Technologies Program:
http://www1.eere.energy.gov/hydrogenandfuelcells/
Fuel Cell bus:
www.actransit.org/environment/hyroad_main.wu
PRAC: www.chpcenterpr.org

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